Chapter 430 Modified Design Level

430.01 General

Modified design level (M) preserves and improves existing roadway geometrics, safety, and operational elements. This chapter provides the design that is unique to the modified design level.

The modified design level design criteria have been developed to apply to all applicable functional classes. As a result, for the lower volumes and urban highways modified design level design criteria might exceed full level design criteria. In these cases, full level design criteria may be used.

Projects developed to correct a deficiency, must address all design elements contributing to that deficiency, even when those elements meet modified design level design criteria

Design elements that do not have modified design level guidance include:

- Lane Transitions, Chapter 620
- On and off connections, Chapter 940
- Access control, Chapter 1420
- Clear zone, Chapter 700
- Signing, delineation, and illumination, Chapters 820, 830, and 840
- Basic safety, Chapter 410
- Structural capacity, Chapter 1120
- Vertical clearance, Chapter 1120
- Intersection sight distance, Chapter 910
- Traffic Barriers, Chapter 710

430.02 Design Speed

When applying modified design level to a project, select a design speed for use in the design process that reflects the character of the terrain and the type of highway. The desirable design speed for modified design level is given in Figure 430-1. The minimum design speed is not less than the posted speed, or the proposed posted speed. (See Chapter 440 for additional information on design speed.) Document which speed was used, include any supporting studies and data.

Route Type	Posted Speed	Desirable Design Speed
Freeways	All	10 mph over the posted speed
non-Freeways	45 mph or less	Not less than the posted speed
	Over 45 mph	5 mph over posted speed

Desirable Design Speed
Figure 430-1

When the posted speed exceeds the design speed for existing geometric features that are to remain in place (curve radius, superelevation, sight distance, or other elements that the design speed controls) one of two choices must be made:

- When appropriate, work with the region Traffic Office to lower the posted speed to be consistent with the existing design speeds for the geometric features on the facility.
- A corridor analysis can be completed in order to leave the posted speed unchanged and identify all design elements that do not meet the criteria for the existing posted speed. Identify each appropriate location for cautionary signing (including road approach sight distance) and work with the region Traffic Office to install the cautionary signing as provided for in the MUTCD (either by contract or region sign personnel). Consult with and obtain guidance from Region Project Develpment leadership prior to progressing with the corridor analysis and the design.

430.03 Alignment

(1) Horizontal Alignment

Consideration of horizontal alignment for modified design level is normally limited to curves. Curve design is controlled by the design speed [430.02], superelevation [430.03(4)], and stopping sight distance [430.03(3)].

Identify major modifications to horizontal alignment in the Project Summary. Total removal of pavement and reconstruction of the subgrade are examples of major modifications.

(2) Vertical Alignment

Vertical alignment consists of a series of profile grades connected by vertical curves.

(a) ***Vertical curves.*** Stopping sight distance controls crest vertical curves. Figure 430-8 gives the minimum curve length for crest vertical curves to remain in place for modified design level stopping sight distance. See 430.03(3) for additional information on modified design level stopping sight distance.

When modified design level is being applied, existing sag vertical curves are not normally addressed.

When either a crest or a sag vertical curve is to be reconstructed, use full design level design criteria (see Chapters 630 and 650).

(b) ***Profile Grades.*** When applying modified design level, profile grades generally are not flattened. However, corrective action may be justified for combinations of steep grades and restricted horizontal or vertical curvature. Identify major modifications to vertical alignment in the Project Summary. Total removal of pavement and reconstruction of the subgrade are examples of major modifications. When changing the profile grade, see Chapter 440 for the maximum grade for the functional class of the route.

(3) Stopping Sight Distance

Stopping sight distance is a controlling factor for both vertical and horizontal alignment. A 2-foot object height is used for modified design level stopping sight distance evaluation. Figure 430-2 gives the minimum stopping sight distances allowed to remain in place.

Design Speed (mph)	Design Stopping Sight Distance (ft)
40 or less	155
45	200
50	250
55	305
60	360
65	425
70	495
75	570
80	645

Stopping Sight Distance, Modified Design Level
Figure 430-2

(a) ***Stopping Sight Distance for Horizontal Curves.*** For modified design level, use the existing lateral clearance to the sight obstruction and the curve radius to compare the existing condition to Figure 430-9a. When reconstructing a horizontal curve, apply full design level criteria for sight distance. (See Chapter 650.)

For Figure 430-9a, an obstruction is any object with a height of greater than 2.75 feet above the roadway surface on the inside of a curve. Examples of possible obstructions are median barrier, guardrail, bridges, walls, cut slopes, wooded areas, and buildings. Objects between 2.75 feet and 2.00 feet above the roadway surface within the M distance might be a sight obstruction, depending on the distance from the roadway. See Figure 430-9b for guidance on determining if an object between 2.75 feet and 2.00 feet above the roadway surface is a sight obstruction.

(b) ***Stopping Sight Distance for Vertical Curves.*** For existing crest vertical curves use the algebraic difference in grades and the length of curve to compare the existing condition to the stopping sight distance requirements from Figure 430-2. Use the equations in Figure 430-3 or use Figure 430-8 to evaluate the existing curve.

When a crest vertical curve is lengthened, the minimum sight distance is increased; however, the length of the roadway that has the minimum sight distance is also increased. This results in a questionable benefit when the new sight distance is less than for full design level. Therefore, when the existing roadway is reconstructed to improve stopping sight distance, apply full design level criteria. (See Chapter 650.)

When s is less than L:

$$L = \frac{As^2}{2158}$$

When s is greater than L:

$$L = 2s - \frac{2158}{A}$$

Where:
- L = Length of vertical curve, ft
- s = Sight distance, ft (Figure 430-2)
- A = Absolute value of the algebraic difference in grades, %

Minimum Crest Vertical Curve Length, Modified Design Level
Figure 430-3

(4) Superelevation

Evaluate existing superelevation using the equation in Figure 430-4. When the existing superelevation equals or exceeds the value from the equation, the modified design level design criteria is met.

When modifying the superelevation of an existing curve where the existing pavement is to remain in place, use the equation in Figure 430-4 to determine the required superelevation.

For curves on realigned roadways or where the roadway is to be rebuilt, provide full design level superelevation (See Chapter 642).

$$e = \left(\frac{6.69V^2}{R}\right) - f$$

Where:
- R = Existing curve radius in ft.
- V = Design speed in mph from 430.02.
- e = Superelevation rate in %.
- f = Side friction factor from Figure 430-5.

Minimum Superelevation, Modified Design Level
Figure 430-4

Design Speed (mph)	Side Friction Factor (f)
15	17.5
20	17
25	16.5
30	16
35	15.5
40	15
45	14.5
50	14
55	13
60	12
65	11
70	10
75	9
80	8

Side Friction Factor
Figure 430-5

430.04 Roadway Widths

Review route continuity and roadway widths. Select widths on the tangents to be consistent throughout a given section of the route. Make any changes where the route characteristics change. The design of a project must not decrease the existing roadway width.

(1) Lane and Shoulder Width

Lane and shoulder widths are shown in Figures 430-10 and 11. Consider joint use with other modes of transportation in shoulder design.

Minimum ramp lane and shoulder widths are shown on Figure 430-14. Use full design level lane and shoulder widths (See Chapter 940) for new and rebuilt ramps.

(2) Turning Roadway Widths

It might be necessary to widen the roadway on curves to accommodate large vehicles. The proposed roadway width for a curve shall not be less than that of the adjacent tangent sections.

Widening of the total roadway width of a curve by less than 2-feet is not required for existing two-lane roadways that are to remain in place.

(a) ***The two-lane two-way roadway*** width of a curve may not be less than that shown in Figure 430-12a or, if the internal angle (delta) is less than 90 degrees, Figure 430-12b. The minimum total roadway width from Figure 430-12a or 12b may include the shoulder. When the shoulder is included, full-depth pavement is required.

(b) ***One-way roadway and Ramp*** widths on a curve are shown in Figure 430-6 for existing roadways that are to remain in place. Use full design level width (See Chapters 641 and 940) for new and rebuilt ramps.

(3) Median Width

Minimum median widths are given in Figure 430-10.

430.05 Cross Slope

On all tangent sections, the normal cross slopes of the traveled way are 2 percent.

If a longitudinal contiguous section of pavement is to be removed or is on a reconstructed alignment, or if a top course is to be placed over existing pavement, design the restored pavement cross slope to full design level criteria (See Chapter 640).

The algebraic difference in cross slopes is an operational factor during a passing maneuver on a two-lane two-way roadway. Its influence increases when increased traffic volumes decrease the number and size of available passing opportunities.

A somewhat steeper cross slope may be necessary to facilitate pavement drainage in areas of intense rainfall, even though this might be less desirable from the operational point of view. In such areas, the design cross slopes may be increased to 2.5 percent with an algebraic difference of 5 percent.

For existing pavements, cross slopes within a range of 1 to 3 percent may remain if there are no operational or drainage problems and — on a two-lane two-way roadway — the following conditions are met:

- The algebraic difference is not greater than 4 percent where the ADT is greater than 2,000.
- The algebraic difference is not greater than 5 percent where the ADT is 2,000 or less.
- The algebraic difference is not greater than 6 percent and the road is striped or signed for no passing.

Curve Radius (ft)	One-Lane(1)	Two-Lane(2)
Tangent to 1,001	20	24
500	21	25
400	21	25
300	22	25
200	22	26
150	23	26
100	25	28
75	27	29
50	30	31

(1) Includes the shoulder width.
(2) Add shoulder widths from Figure 430-10 for highways and 10 ft for ramps.

One-Way Roadway and Ramp Turning Roadway Widths, Modified Design Level
Figure 430-6

For a two-lane two-way roadway, provide an algebraic difference to meet the appropriate conditions stated above, except when facilitating drainage in areas of intense rainfall. When applying modified design level to a road with bituminous surface treatment (BST), cross slope correction is not required on the basis of algebraic differences alone.

To maintain or restore curb height, consider lowering the existing pavement level and correcting cross slope by grinding before an asphalt overlay. The cross slope of the shoulder may be steepened to maximize curb height and minimize other related impacts. The shoulder may be up to 6 percent with a rollover between the traveled way and the shoulder of no more than 8 percent. See Chapter 640 for additional information.

430.06 Side Slopes

(1) Fill/Ditch Slopes

Foreslopes (fill slopes and ditch inslopes) and cut slopes are designed as shown in the Fill and Ditch Slope Selection Table on Figure 430-13 for modified design level main line roadway sections. After the foreslope has been determined, use the guidance in Chapter 700 to determine the need for a traffic barrier.

When a crossroad or road approach has steep foreslopes, there is the possibility that an errant vehicle might become airborne. Therefore, flatten crossroad and road approach foreslopes to 6H:1V where practical and at least to 4H:1V. Provide smooth transitions between the main line foreslopes and the crossroad or road approach foreslopes. Where possible, move the crossroad or road approach drainage away from the main line. This can locate the pipe outside the design clear zone and reduce the length of pipe required.

(2) Cut Slopes

Existing stable backslopes (cut slopes) are to remain undisturbed unless disturbed by other work. When changes are required to a cut slope, design them as shown in the Cut Slope Selection Table on Figure 430-13.

430.07 Bike and Pedestrian

Sidewalk ramps must be addressed for Americans with Disabilities Act of 1990 (ADA) compliance on projects that include hot mix asphalt (HMA) or Portland cement concrete pavement (PCCP) overlays or inlays. Evaluate existing sidewalk ramps for compliance. Construct ADA compliant sidewalk ramps as required.

On Interstate Pavement Rehab./Resurface projects (See Chapter 325) that include HMA or PCCP overlays, or inlays on ramps or crossroads, sidewalk ramps must be addressed for ADA compliance. Other bicycle or pedestrian elements are design exceptions on HMA or PCCP overlays or inlays on Interstate ramps or crossroads.

Projects that widen the roadway, or change the traffic configuration by reducing the shoulders to add turn lanes are considered alterations of the roadway. Such alterations include a requirement to address ADA compliance for sidewalk ramps.

See Chapter 1025 for guidance on pedestrian facilities.

430.08 Bridges

Design all new and replacement bridges to full design level (See Chapter 440) unless a corridor or project analysis justifies the use of modified design level lane and shoulder widths. Evaluate bridges to remain in place using Figures 430-10 and 11. Whenever possible, continue the roadway lane widths across the bridge and adjust the shoulder widths.

Consider joint use with other modes of transportation in lane and shoulder design. See Chapters 1020, 1025, 1050, and 1060.

430.09 Intersections

Except as given below, design intersections to meet the requirements in Chapter 910.

(1) Turn Radii

The intersection turn radii (or right-turn corners) are controlled by the design vehicle. Figure 430-7 is a guide for determining the design vehicle for modified design level. Perform a field review to determine intersection type, types of vehicles that use the intersection, and adequacy of the existing geometrics. When the crossroad is a city street or county road, consider the requirements of the city or county when selecting a design vehicle.

Design right turn corners to meet the requirements of Chapter 910 using the design vehicle selected from Figure 430-7 or from the field review.

(2) Angle

The allowable angle between any two respective legs is between 60° and 120°. When realignment is required to meet this angle requirement, consider realigning to an angle between 75°and 105°.

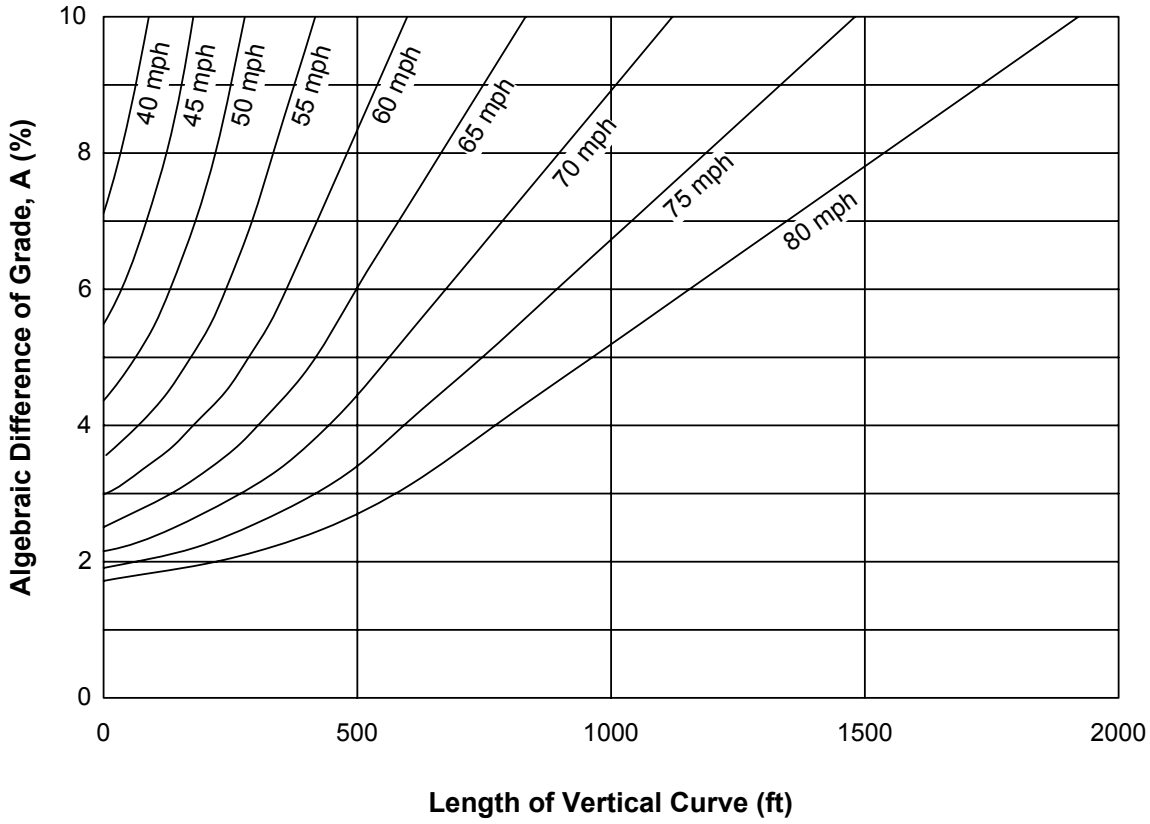
Intersection Type	Design Vehicle
Junction of Major Truck Routes	WB-67
Junction of State Routes	WB-40
Ramp Terminals	WB-40
Other Rural	SU(1)
Urban Industrial	SU(1)
Urban Commercial	P(1)
Residential	P(1)

(1) When the intersection is on a transit or school bus route, use the BUS design vehicle. See Chapter 1060 for additional guidance for transit facilities and for the BUS turning path templates.

Design Vehicles, Modified Design Level
Figure 430-7

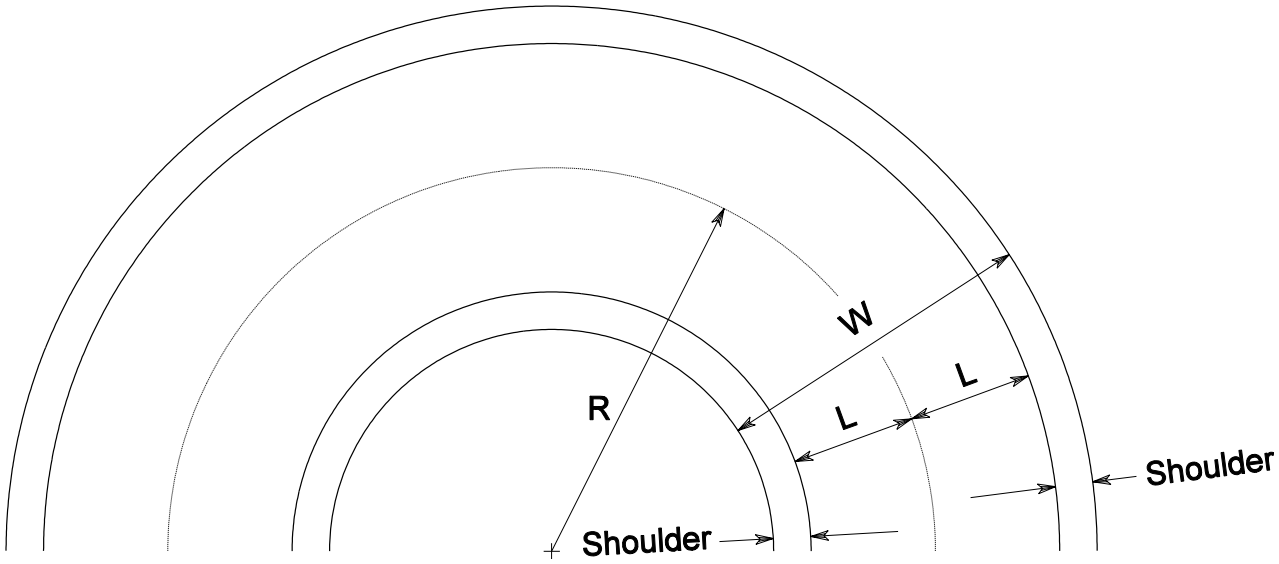
430.10 Documentation

A list of the documents that are to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following web site:
http://www.wsdot.wa.gov/eesc/design/projectdev/

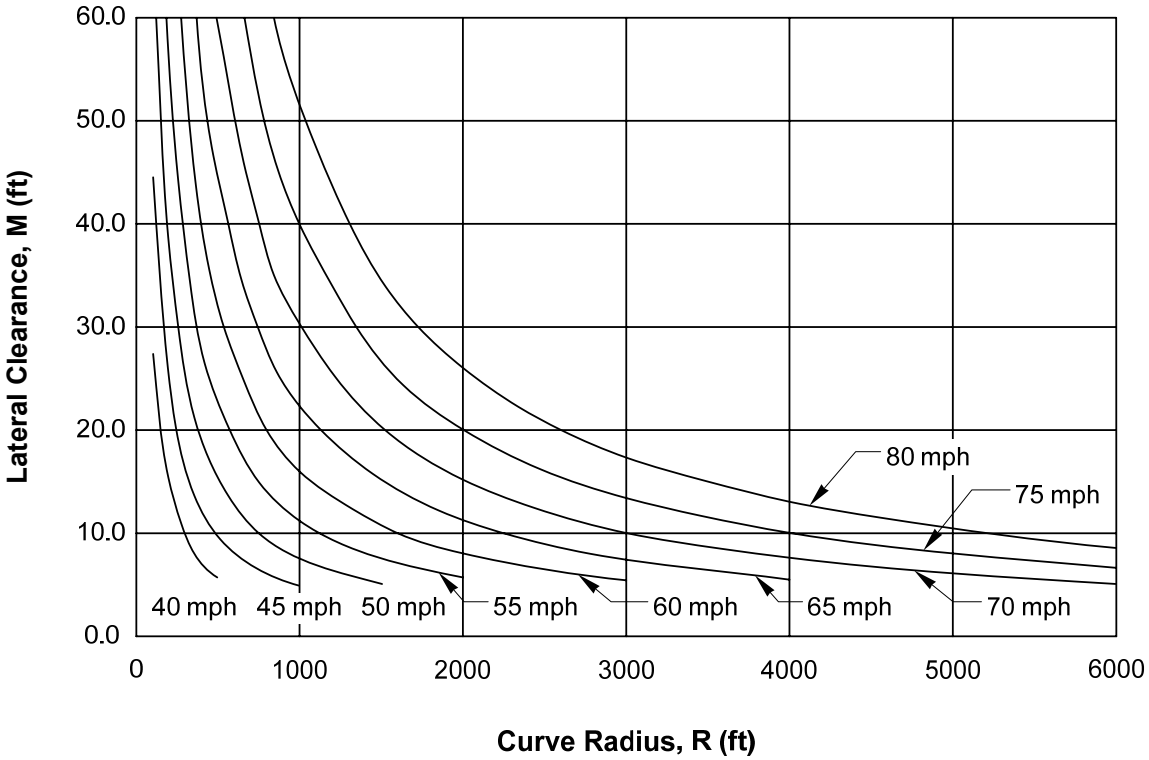


When the intersection of the algebraic difference of grade with the length of vertical curve is below the selected design speed line, modified design level design criteria is met.

Evaluation for Stopping Sight Distance for Crest Vertical Curves, Modified Design Level
Figure 430-8



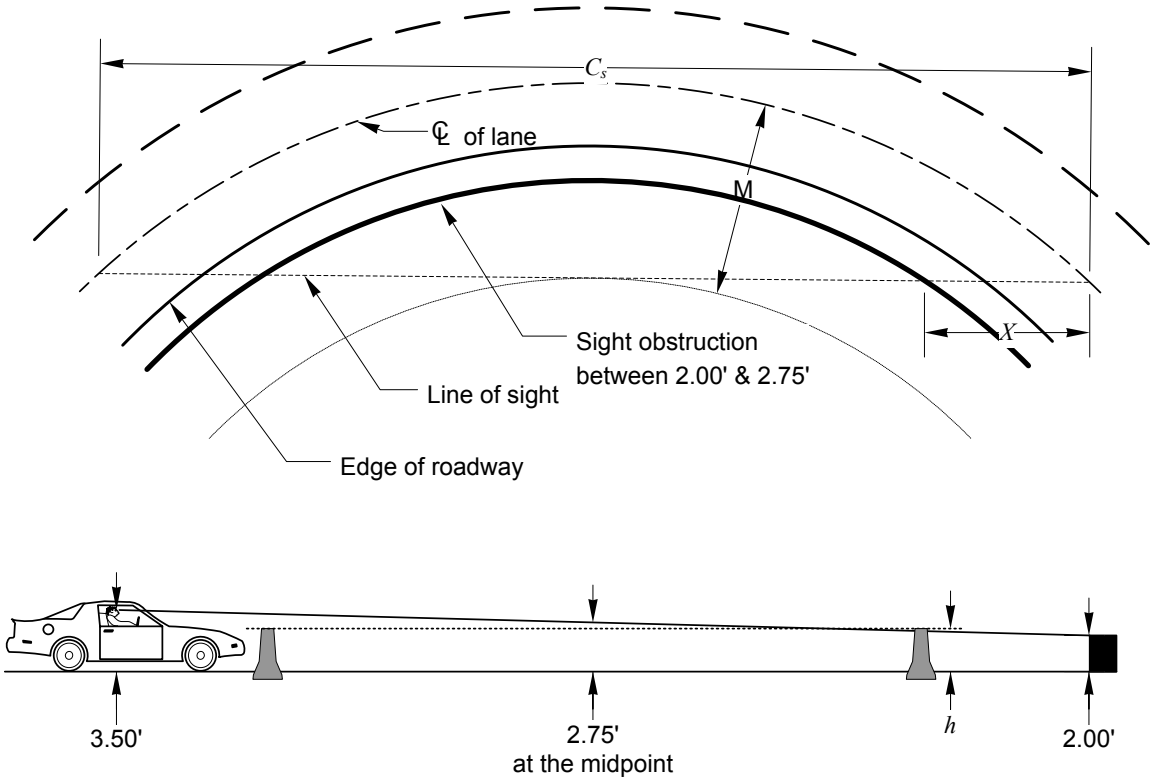
M is the distance in feet from the center line of the inside lane to the obstruction. Obstruction is a cut slope or other object 2.75 ft or more above the inside lane. Objects between 2.75 ft and 2.00 ft above the roadway surface within the M distance might be a sight obstruction, depending on the distance from the roadway. See Figure 430-9b.



When the intersection of the lateral clearance (M) with the curve radius (R) falls above the curve for the selected design speed, modified design criteria is met.

Evaluation for Stopping Sight Distance for Horizontal Curves, Modified Design Level

Figure 430-9a



When $h \leq \left(2 + \frac{1.5X}{C_s}\right)$ modified design criteria is met.

Where:

M = Lateral clearance for sight distance (ft) See Figure 430-9a
C_S = Stopping sight distance chord (ft)
X = Distance from the sight obstruction to the end of the sight distance chord (ft)
h = Height of sight obstruction above the inside lane.

Evaluation for Stopping Sight Distance Obstruction for Horizontal Curves, Modified Design Level

Figure 430-9b

	Multilane Divided				Multilane Undivided			
	Trucks Under 10%		Trucks 10% and Over		Trucks Under 10%		Trucks 10% and Over	
Design Class	MDL-1	MDL-2	MDL-3	MDL-4	MDL-5	MDL-6	MDL-7	MDL-8
Current ADT (1)	Under 4000	Over 4000	Under 4000	Over 4000	Under 4000	Over 4000	Under 4000	Over 4000
Design Speed	See Figure 430-1							
Traffic Lanes Number Width	4 or more 11 ft	4 or more 11 ft	4 or more 11 ft	4 or more 12 ft	4 or more 11 ft	4 or more 11 ft	4 or more 11 ft	4 or more 12 ft
Parking Lanes Urban	None	None	None	None	8 ft	8 ft (2)	8 ft	8 ft (2)
Median Width Rural Urban	Existing Existing	Existing Existing	Existing Existing	Existing Existing	2 ft 2 ft	4 ft 2 ft	4 ft 2 ft	4 ft 2 ft
Shoulder Width Right (3) Left (4)	4 ft 2 ft	6 ft 2 ft	4 ft 2 ft	6 ft 2 ft	4 ft	6 ft (5)	4 ft	6 ft (5)
Minimum Width for Bridges to Remain in Place (6) (7) (8)	24 ft (9)	26 ft (9)	24 ft (9)	26 ft (10)	48 ft (9)	50 ft (9) (11)	50 ft (9) (11)	54 ft (10) (11)
Minimum Width for Rehabilitation of Bridges to Remain in Place (6) (8) (12)	28 ft (9)	30 ft (9)	28 ft (9)	32 ft (10)	54 ft (9)	60 ft (9) (11) (13)	56 ft (9) (11)	64 ft (10) (11) (13)
Minimum Width for Replacement Bridges	Full Design Level Applies (14)							
Access Control	See Chapters 1430 and 1435 and the Master Plan for Limited Access Highways, or WAC 468-52 and the region's Highway Access Management Classification Report							

Notes:

(1) If current ADT is approaching a borderline condition, consider designing for the higher classification.

(2) Parking restricted when ADT is over 15,000.

(3) When curb section is used, the minimum shoulder width from the edge of traveled way to the face of curb is 4 feet. In urban areas, see Chapter 440. On a route identified as a local, state, or regional significant bicycle route the minimum shoulder width is 4 feet (See Chapter 1020).

(4) When a curb section is used, the minimum shoulder width from the edge of traveled way to the face of the curb is 1 foot on the left.

(5) May be reduced by 2 feet under urban conditions.

(6) Width is the clear distance between curbs or rails, whichever is less.

(7) Use these widths when a bridge within the project limits requires deck treatment or thrie beam retrofit only.

(8) For median widths 25 feet or less, see Chapter 1120.

(9) Add 11 feet for each additional lane.

(10) Add 12 feet for each additional lane.

(11) Includes a 4-foot median, which may be reduced by 2 feet under urban conditions.

(12) Use these widths when a bridge within the project limits requires any work beyond the treatment of the deck such as bridge rail replacement, deck replacement, or widening.

(13) Includes 6-foot shoulders — may be reduced by 2 feet on each side under urban conditions.

(14) Modified design level lane and shoulder widths may be used when justified with a corridor or project analysis.

Multilane Highways and Bridges, Modified Design Level

Figure 430-10

	Two-Lane Highways					
	Trucks Under 10%			Trucks 10% and Over		
Design Class	MDL-9	MDL-10	MDL-11	MDL-12	MDL-13	MDL-14
Current ADT (1)	Under 1000	1000-4000	Over 4000	Under 1000	1000-4000	Over 4000
Design Speed	See Figure 430-1					
Traffic Lane Width (2)	11 ft	11 ft	11 ft	11 ft	11 ft	12 ft
Parking Lanes Urban	8 ft	8 ft	8 ft (3)	8 ft	8 ft	8 ft (3)
Shoulder Width (4)	2 ft	3 ft (5)	4 ft	2 ft	3 ft (5)	4 ft
Minimum Width for Bridges to Remain in Place (6)(7)	22 ft (8)	24 ft	28 ft	22 ft (8)	24 ft	28 ft
Minimum Width for Rehabilitation of Bridges to Remain in Place (7)(9)	28 ft (10)	32 ft	32 ft	28 ft (10)	32 ft	32 ft
Minimum Width for Replacement Bridges	Full Design Level Applies (11)					
Access Control	See Chapters 1430 and 1435 and the Master Plan for Limited Access Highways, or WAC 468-52 and the region's Highway Management Classification Report.					

Notes:

(1) If current ADT is approaching a borderline condition, consider designing for the higher classification.

(2) See Figures 430-12a and 12b for turning roadways.

(3) Parking restriction recommended when ADT exceeds 7,500.

(4) When a curb section is used, the minimum shoulder width from the edge of traveled way to the face of curb is 4 feet. In urban areas, see Chapter 440. On a route identified as a local, state, or regional significant bicycle route the minimum shoulder width is 4 feet (See Chapter 1020).

(5) For design speeds of 50 mph or less on roads of 2,000 ADT or less, width may be reduced by 1 foot, with justification.

(6) Use these widths when a bridge within the project limits requires deck treatment or thrie beam retrofit only.

(7) Width is the clear distance between curbs or rails, whichever is less.

(8) 20 feet when ADT 250 or less.

(9) Use these widths when a bridge within the project limits requires any work beyond the treatment of the deck such as bridge rail replacement, deck replacement, or widening.

(10) 26 feet when ADT 250 or less.

(11) Modified design level lane and shoulder widths may be used when justified with a corridor or project analysis.

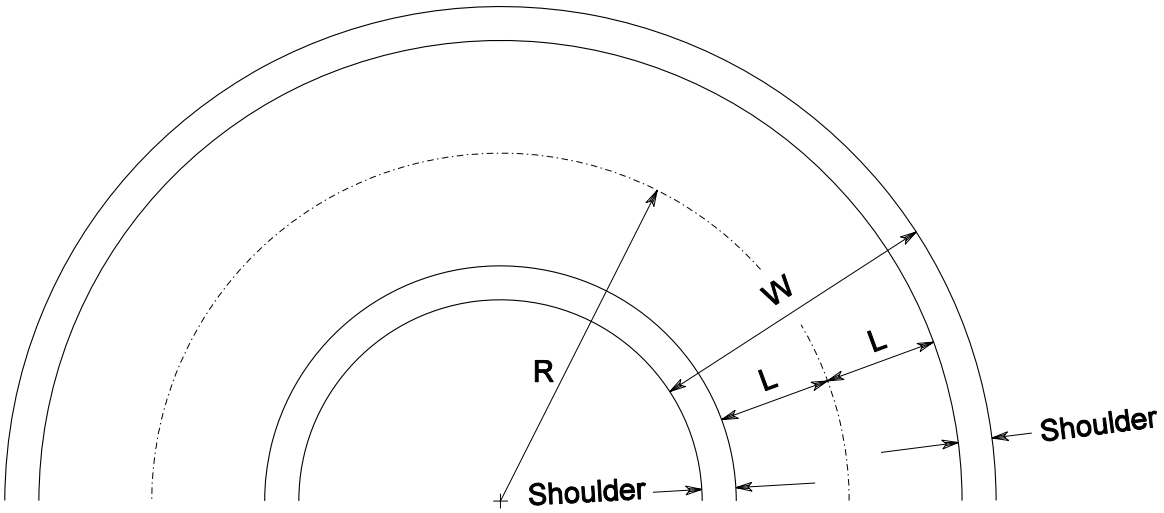
Two-Lane Highways and Bridges, Modified Design Level

Figure 430-11

Radius of Center Line R (ft)	Minimum Total Roadway Width W (ft)	Minimum Lane Width L (ft)
Tangent	26	11
900	26	11
800	27	12
700	27	12
600	28	12
500	28	12
400	29	12
350	30	12
300	31	12
250	33	13
200	35	13
150	39	13

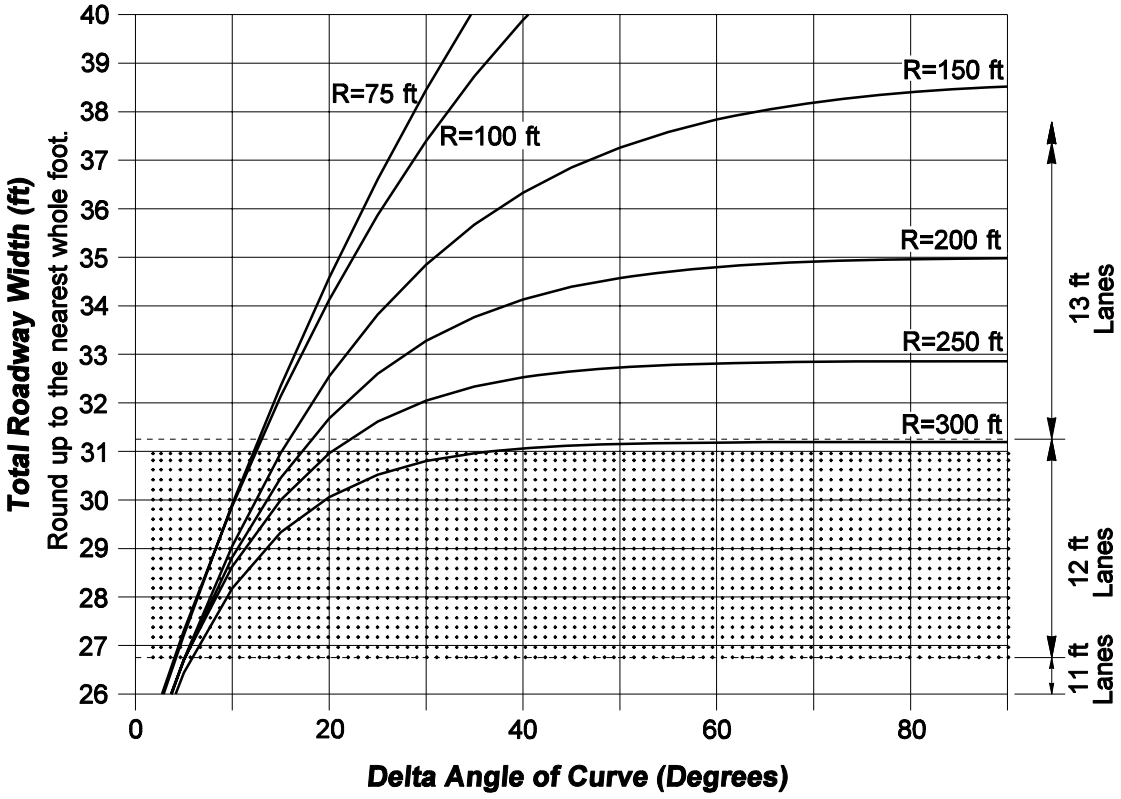
Note:

Also see minimums from Figure 430-11. If the minimum total roadway width is greater than the sum of the shoulders and lane widths, apply the extra width to the inside of the curve.



Minimum Total Roadway Widths for Two-Lane Two-Way Highway Curves, Modified Design Level

Figure 430-12a

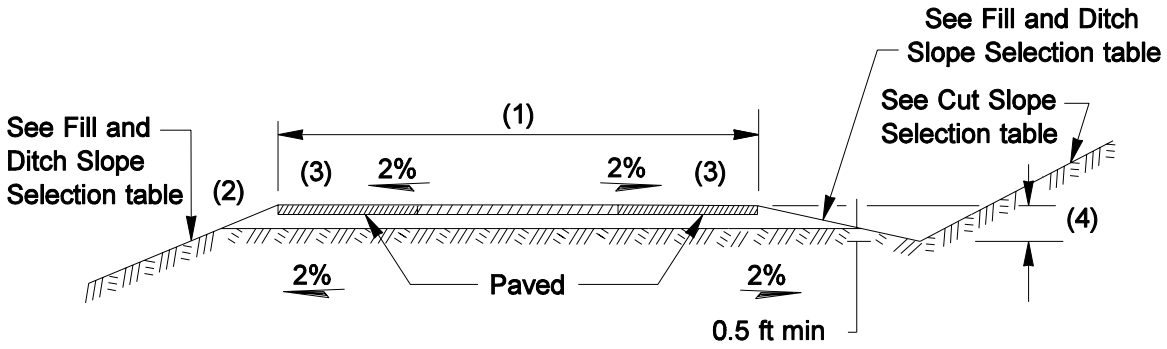


Notes:

May be used when the internal angle (delta) is less than 90 degrees.
If result is less than the total roadway width from Figure 430-11, use the greater.

Minimum Total Roadway Widths for Two-Lane Two-Way Highway Curves, Modified Design Level

Figure 430-12b



Height of Cut (ft)	Slope not Steeper than (5)
0 - 5	4H:1V
5 - 20	3H:1V
over 20	2H:1V

Cut Slope Selection Table

Height of Fill/Depth of Ditch (ft)	Slope not Steeper than
0 - 20	4H:1V
20 - 30	3H:1V
over 30	2H:1V(6)(7)

Fill and Ditch Slope Selection Table

Notes:

(1) See Figures 430-10 and 11 for minimum roadway widths and Figures 430-12a and 12b for turning roadway widths.

(2) Widen and round embankments steeper than 4H:1V.

(3) See Chapter 640 for shoulder slope requirements.

(4) Minimum ditch depth is 2 feet for design speeds over 40 mph and 1.5 feet for design speeds 40 mph or less.

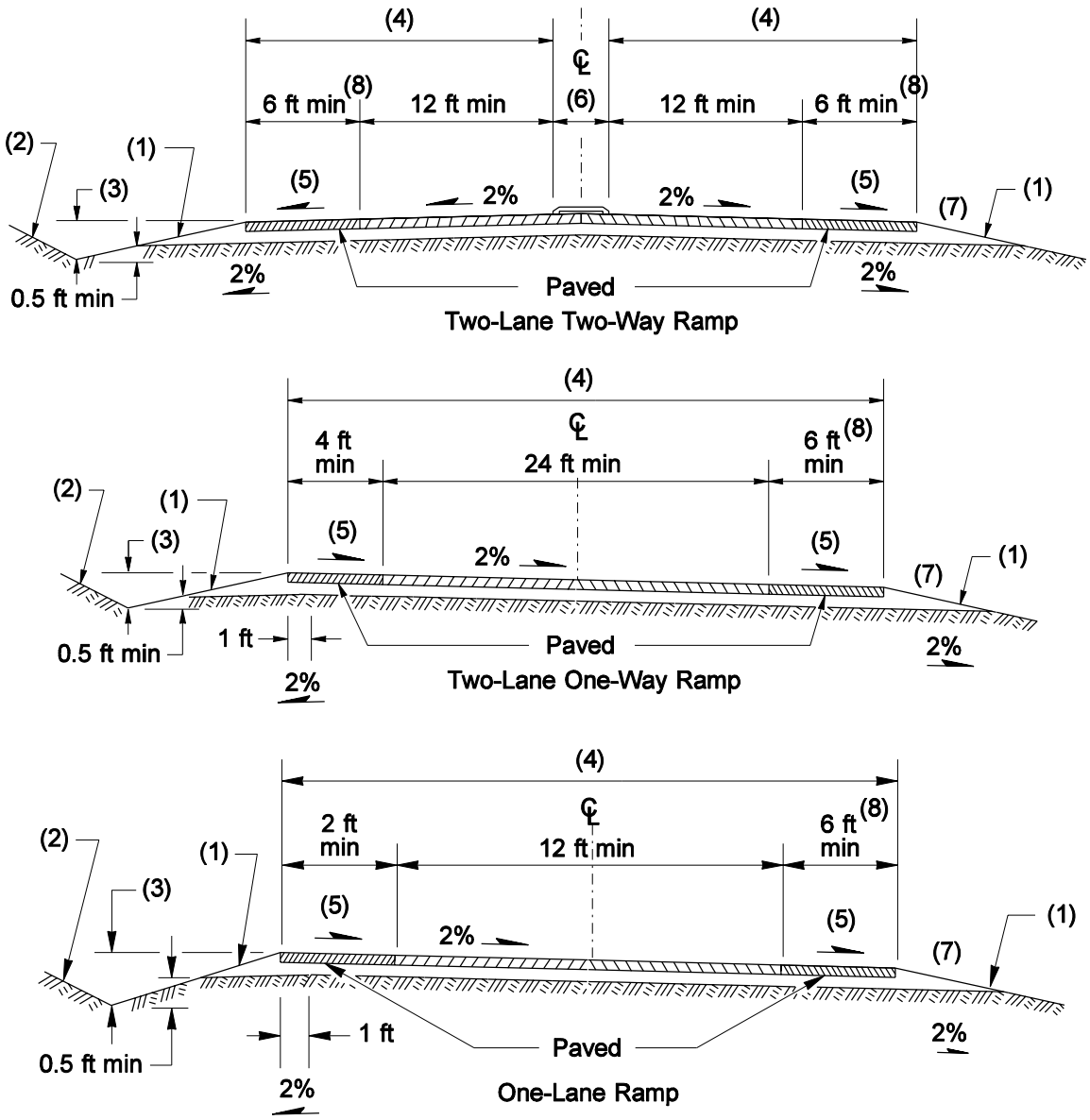
(5) Or as recommended by the soils or geothechnical report. Refer to Chapter 700 for clear zone and barrier requirements

(6) Where practical, provide flatter slopes for the greater fill heights and ditch depths.

(7) Fill slopes up to 1 1/2H:1V may be used where favorable soil conditions exist. Refer to Chapter 640 for additional details and Chapter 700 for clear zone and barrier requirements.

Main Line Roadway Sections, Modified Design Level

Figure 430-13



Notes:

(1) See Fill and Ditch Slope Selection Table on Figure 430-13.
(2) See Cut Slope Selection Table on Figure 430-13
(3) Minimum ditch depth is 2 feet for design speeds over 40 mph and 1.5 feet for design speeds at and under 40 mph.
(4) See 430.04(2)(b) and Figure 430-6 for minimum ramp width.
(5) See Chapter 640 for shoulder slope requirements.
(6) The median width of a two-lane two-way ramp shall not be less than that required for traffic control devices and their required shy distances.
(7) Widen and round embankments steeper than 4H:1V.
(8) Existing 6 feet may remain. When the roadway is to be widened, 8 feet is preferred.

Ramp Roadway Sections, Modified Design Level

Figure 430-14